

1
2 What is claimed is:
3
4 1. A method for forming an amorphous shallow implant region that getters defects from a
5 pocket implantation; comprising:
6 a) providing a gate structure, on a substrate comprised with a first conductivity type
7 dopant; said substrate comprised of an upper crystalline section;
8 b) performing a pocket amorphizing implantation procedure to implant ions of a
9 second conductivity type to form a pocket implant region adjacent to
10 said gate structure, an amorphous pocket region;
11 (1) said amorphous pocket region is formed at a first depth below the
12 substrate surface;
13 c) performing a shallow amorphizing implant to form an amorphous shallow
14 implant region;
15 (1) said amorphous shallow implant region being formed at a second
16 depth above said amorphous pocket region;
17 d) performing an anneal procedure to recrystallize the amorphous shallow implant
18 region and said amorphous pocket region, whereby said amorphous
19 shallow implant region reduces defects formed by the pocket
20 amorphizing implant.

- 1 2. The method of claim 1 wherein the anneal procedure is comprised of a first soak step
- 2 and a second spike step.
- 3 3. The method of claim 1 wherein said amorphous pocket region is formed at a depth
- 4 between 40 and 100 nm; said amorphous pocket region has a thickness between 10
- 5 and 20 nm;
- 6 and the substrate above the amorphous pocket region remains crystalline.
- 7 4. The method of claim 1 wherein the pocket amorphizing implantation comprises
- 8 implanting Sb or In species at an energy between 115 and 150 keV using a quad
- 9 implant at a 45 degree angle to form a pocket implant to a depth between 40 and 100
- 10 nm.
- 11 5. The method of claim 1 wherein the shallow amorphizing implant comprises: implanting
- 12 As, Si, Ge or N species at a dose between $5E13\text{cm}^{-2}$ and $7E14\text{ cm}^{-2}$ and at an energy
- 13 between 5 and 10 keV, and preferably at a 7 degree and a quad twist.
- 14 6. The method of claim 1 wherein said amorphous shallow implant region is formed at a
- 15 minimum depth of about 8 nm and a maximum depth of 20 nm below the substrate
- 16 surface; said amorphous shallow implant region has a thickness between 5 and 10 nm.
- 17 7. The method of claim 1 wherein the anneal procedure comprises: (1) a soak step at a
- 18 temperature between 600 and 800 °C for a time between 10 and 30 seconds and (2) a
- 19 spike step where the temperature ramps up to a peak temperature between 1000 and
- 20 1100 °C and a ramp down from said peak temperature to a temperature below 800 °C;
- 21 said ramp up and ramp down have a rate between 200 and 300 degree °C per minute.

1

2 8. A method for forming an amorphous shallow implant region that getters defects from a

3 pocket implantation; comprising:

4 a) providing a gate structure, on a substrate comprised with a first conductivity type

5 dopant; said substrate comprised of an upper crystalline section;

6 b) performing a pocket amorphizing implantation procedure to implant ions of a

7 second conductivity type to form a pocket implant region adjacent to

8 said gate structure, an amorphous pocket region;

9 (1) said amorphous pocket region is formed at a first depth below the

10 substrate surface;

11 c) performing a shallow amorphizing implant to form an amorphous shallow

12 implant region;

13 (1) said amorphous shallow implant region being formed at a second

14 depth above said amorphous pocket region;

15 d) performing a SDE implant to form SDE regions of a second conductivity type

16 using said gate structure as a mask;

17 e) performing a source/drain implant procedure to form deep source/drain regions;

18 f) performing an anneal procedure to recrystallize the amorphous shallow implant

19 region and said amorphous pocket region, whereby said amorphous

1 15. The method of claim 8 wherein the S/D implant procedure comprises: implanting As
2 ions at a dose of between 5E13 and 7E14 atoms/sq-cm; an energy between 5 and 10
3 keV and a maximum depth between 30 and 50 nm.

4 16. The method of claim 8 wherein the anneal procedure comprises: (1) a soak step at a
5 temperature between 600 and 800 °C for a time between 10 and 30 seconds and (2) a
6 spike step where the temperature ramps up to a peak temperature between 1000 and
7 1100 °C and a ramp down from said peak temperature to a temperature below 800 °C;
8 said ramp up and ramp down have a rate between 200 and 300 degree °C per minute.

9

10 17. A method of for a pocket implant comprising:

11 a) providing a gate structure on a semiconductor substrate comprised with a first
12 conductivity type dopant;

13 b) performing a pocket amorphizing implantation procedure to form a pocket
14 implant region adjacent to said gate structure, an amorphous pocket
15 region and pocket interstitials under the amorphous pocket region;

16 c) performing a shallow amorphizing implant to form an amorphous shallow
17 implant region and shallow implant interstitials; the amorphous
18 shallow implant region being formed at a second depth above said
19 amorphous pocket region;

20 the substrate above the amorphous shallow implant
21 region remains crystalline;

1 shallow implant region reduces defects formed by the pocket
2 amorphizing implant.

3 9. The method of claim 8 wherein the anneal procedure is comprised of a first soak step
4 and a second spike step.

5 10. The method of claim 8 wherein said amorphous pocket region is formed at a depth
6 between 40 and 100 nm; said amorphous pocket region has a thickness between 10
7 and 20 nm;
8 and the substrate above the amorphous pocket region remains crystalline.

9

10 11. The method of claim 8 wherein the pocket amorphizing implantation comprises
11 implanting Sb or In species at an energy between 115 and 150 keV using a quad
12 implant at a 45 degree angle to form a pocket implant to a depth between 40 and 100
13 nm.

14 12. The method of claim 8 wherein the shallow amorphizing implant comprises:
15 implanting As, Si, Ge or N species at a dose between 5E13cm⁻² and 7E14 cm⁻² and at
16 an energy between 5 and 10 keV, and preferably at a 7 degree and a quad twist.

17 13. The method of claim 8 wherein said amorphous shallow implant region is formed at a
18 minimum depth of about 8 nm and a maximum depth of 20 nm below the substrate
19 surface; said amorphous shallow implant region has a thickness between 5 and 10 nm.

20 14. The method of claim 8 wherein said amorphous shallow implant region has a
21 thickness between 5 and 10 nm.

1 (1) said amorphous shallow implant region is formed at a minimum
2 depth of about 8 nm and a maximum depth of 20 nm below the
3 substrate surface; said amorphous shallow implant region has a
4 thickness between 5 and 10 nm;

5

6 d) performing a SDE implant to form SDE regions of a second conductivity type, in
7 an area of said semiconductor substrate not covered by said gate
8 structure, with said SDE regions located in a top portion of said pocket
9 region;

10 e) forming spacers on the sidewalls of the gate structure;

11 f) performing a S/D implant procedure to form Deep S/D regions;

12 g) performing an anneal procedure comprised of a first soak step and a second spike
13 step to recrystallize the amorphous shallow implant region and said
14 amorphous pocket region; whereby said shallow amorphous implant
15 region reduces the defects from the pocket implantation;

16 (1) the anneal procedure comprises (1) a soak step at a temperature
17 between 600 and 800 °C for a time between 10 and 30 seconds and
18 (2) a spike step where the temperature ramps up to a peak
19 temperature between 1000 and 1100 °C and a ramp down from said

peak temperature to a temperature below 800 °C; said ramp up and ramp down have a rate between 200 and 300 degree° C per minute.

3

4 18. The method of claim 17 wherein the pocket amorphizing implantation comprises
5 implanting Sb or In species at an Energy between 115-150 keV using a quad implant
6 at a 45 degree angle to form a pocket implant region to a depth between 40 and 100 nm.

7 19. The method of claim 17 wherein said amorphous pocket region is formed at a depth
8 range between 40 and 100 nm; said amorphous pocket region has a thickness between
9 10 and 20 nm; the substrate above the amorphous pocket region remains crystalline.

10 20. The method of claim 17 wherein the shallow amorphizing implant comprises:

11 implanting As, Si, or Ge species at a dose greater than $5\text{E}13\text{cm}^{-2}$ and at an energy
12 between 5 and 10 keV, and preferably at a 7 degree and a quad twist.